EGU24-908, updated on 22 Apr 2024
https://doi.org/10.5194/egusphere-egu24-908
EGU General Assembly 2024

Proximal Gamma Ray Spectroscopy for monitoring Soil Water Content in vineyards

Michele Franceschi[1,2], Matteo Alberi[1,2], Marco Antoni[3], Ada Baldi[4], Alessio Barbagli[5], Luisa Beltramone[6], Laura Carnevali[7], Alessandro Castellano[8], Giovanni Collodi[7], Enrico Chiarelli[1,2], Tommaso Colonna[5], Vivien De Lucia[6], Andrea Ermini[6], Andrea Maino[1,2], Fabio Gallorini[1,5], Enrico Guastaldi[5], Nicola Lopane[1,2,5], Antonio Manes[8], Fabio Mantovani[1,2], Samuele Messeri[8], Dario Petrone[1,5], Silvio Pierini[5], Kassandra Giulia Cristina Raptis[1,2], Andrea Rindinella[6], Riccardo Salvini[6], Daniele Silvestri[6], Virginia Strati[1,2], and Gerti Xhixha[9]

[1]Department of Physics and Earth Sciences, University of Ferrara, 44122 Ferrara, Italy
[2]INFN Ferrara Section, 44122 Ferrara, Italy
[3]Copernico S.r.l. 53024, Montalcino, Siena, Italy
[4]Department of Agriculture, Food, Environment and Forestry, University of Florence,50144 Firenze, Italy
[5]GeoExplorer Impresa Sociale s.r.l., 52100 Arezzo, Italy
[6]Department of Environment, Earth and Physical Sciences and Centre of Geotechnologies, University of Siena, 52027 San Giovanni Valdarno, Arezzo, Italy
[7]Department of Information Engineering, University of Florence, 50139 Firenze, Italy
[8]Netsens s.r.l., 50041 Calenzano, Firenze, Italy
[9]Department of Physics, Faculty of Natural Sciences, University of Tirana, 1001 Tirana, Albania

Soil Water Content (SWC) is a key information in precision agriculture for obtaining high levels of efficiency and health of crops, while reducing water consumption. In particular, for the case of vineyards, due to the recent extreme temperature fluctuations, the knowledge of the SWC of the entire field becomes crucial to allow a timely intervention with emergency irrigation to preserve plant health and yield.

Unlike electromagnetic SWC measurements, that are punctual and gravimetric measurements, that are punctual and also time-consuming, the Proximal Gamma Ray Spectroscopy (PGRS) technique can provide field-scale, non-invasive, and real-time measurements of SWC. This is achievable through an in-situ NaI detector, continuously recording photons resulting from the radioactive decay of ^{40}K in the soil, which are attenuated proportionally based on the amount of stored water. Given the inverse proportionality between soil moisture and photons detected by the gamma ray sensor, the SWC value can be easily obtained.

In this study we investigate the performance of PGRS applied to the case of study of a vineyard at the farm “Il Poggione” located in Montalcino (Siena, Italy).

The effectiveness of the results obtained is supported by different tests: first the validation allowed to compare the PGRS measurement (5.8 ± 1.5)% with a gravimetric measurement (9.0 ±

2.5)%, highlighting a 1-σ agreement; then by the rainfall recognition capability indeed, in correspondence to the most significant rainfall event (18 mm) the SWC value before and after the rain increased of 7.8%.

Moreover, the integration of the in-situ system with an agrometeorological station resulted in a Web App, allowing for real time data storage and thus facilitating data management, spectrum analysis, and display for both gamma ray sensor and agrometeorological station results, enabling comprehensive studies of environmental parameters (e.g., temperature, air humidity).

This research underlines the potential of PGRS as a precise, real-time, and field scale SWC monitoring tool not only in vineyards but for cultivated fields in general. Further refinements concerning the gamma ray spectra analysis and broader applications in environmental monitoring are envisaged for improved agricultural practices.

This study was supported by the project STELLA (Sistema inTEgrato per Lo studio del contenuto d'acqua in agricoLturA) (CUP: D94E20002180009) funded by the Tuscany region under the program POR FESR 2014/2020.